Preliminary Results from Scan of Flash Lamp radiation pattern with a Quartz fiber mounted on an adjustable three axis table

AAH +MR

Wanted to know sensitivity of light collection in a typical Fibered PrM monitor.

- Fibers are quartz with cleaved faces.
  - Current PrMs use three fibers bundled together and inserted into opening of a Flash Lamp
- Flashlamp is Newport/Oriel Model 6427 Xe 3x2.5mm Large Bulb , 5J, 60W, 9 ms Pulse width, 60Hz Flashlamp
  - Mounted in Model 60000 housing with rear reflector
  - Comment from Newport/Oriel Spectral Irradiance Product training manual—page 38.
    - Note that Au Work function is 5.1eV
      - $\lambda < 250$nm to extract an electron
      - See arrow in spectrum

THE REAR REFLECTOR

The rear reflector captures "backwards emitted radiation," and when properly adjusted, reflects it back through the source to contribute to the total output. This applies particularly to arc lamps which are transparent at most wavelengths. The factor of 1.6 decreases below 350 nm to about 1.2, at 250 nm.

Newport SPECTRAL IRRADIANCE DATA

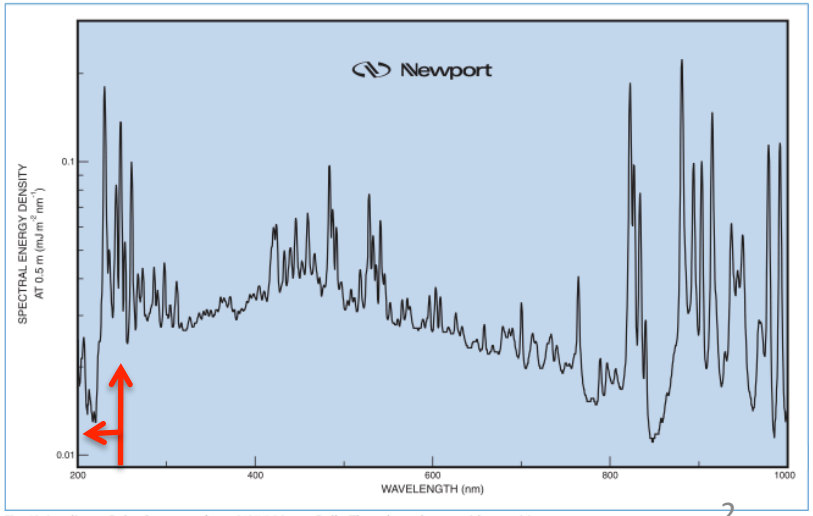
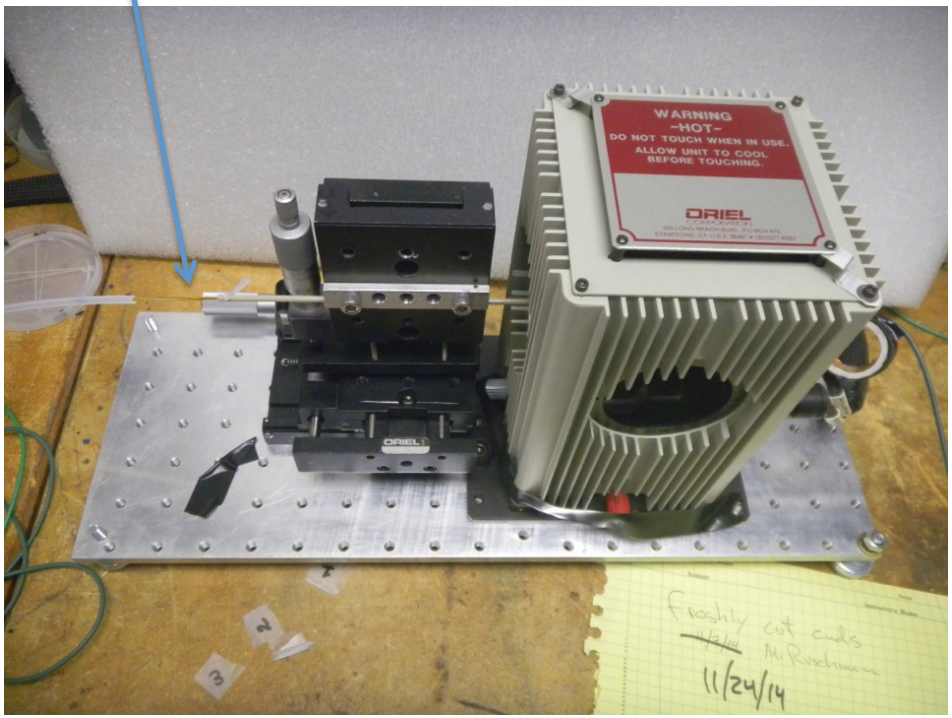


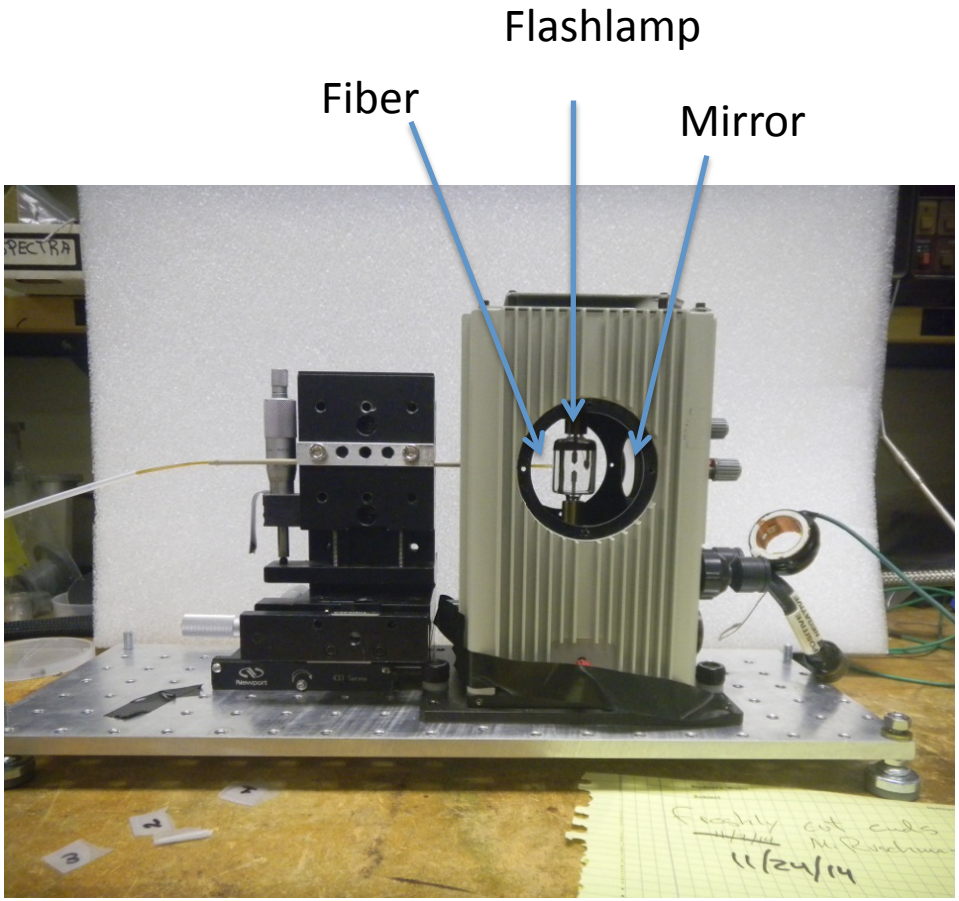
Fig. 18 Irradiance Pulse Spectrum from 6427 5 J Large Bulb. The values change with repetition rate.

Test Setup

- Micrometer adjustable table mounted to move up to three PrM Quartz fibers in opening of Flashlamp housing
  - Fiber was held normal to the vertical axis of flashlamp bulb and parallel to the axis from the center of the housing opening and the flashlamp bulb center (call this the longitudinal axis)
    - Adjustable positioning in vertical and horizontal plane, and along the longitudinal axis.
    - See photo slide #4
- First step was to use a single fiber to scan the three axes to maximize the signal from a PrM (the inline from PC4) that was mounted in a vacuum tank.
- Then with the fiber sitting at the max signal position, the adjustable reflector mirror was adjusted to maximize that signal
- Other two fibers were then individually inserted into the setup (at this max output point) and recordings of their cathode signals taken.
- Then all three fibers were simultaneously inserted into the holder at the nominal max output point—the three fiber ends were constrained to be at the same plane, similar to how we plan to run them in the eventual LAr run.
- Other details on setup
  - Flashlamp set to 2000 mJ.
  - LRS scope used with high impedance DC coupled input
  - Averaged over 10 flashes. Signal quality was pretty good. Estimate statistical fluctuations were ~$\pm$0.005 V in numbers shown in plots/tables.
  - ~-100V on cathode (using pot for value), ~+400V on Anode (have a sparking problem to look into here that limited the anode HV value).

Flashlamp Setup



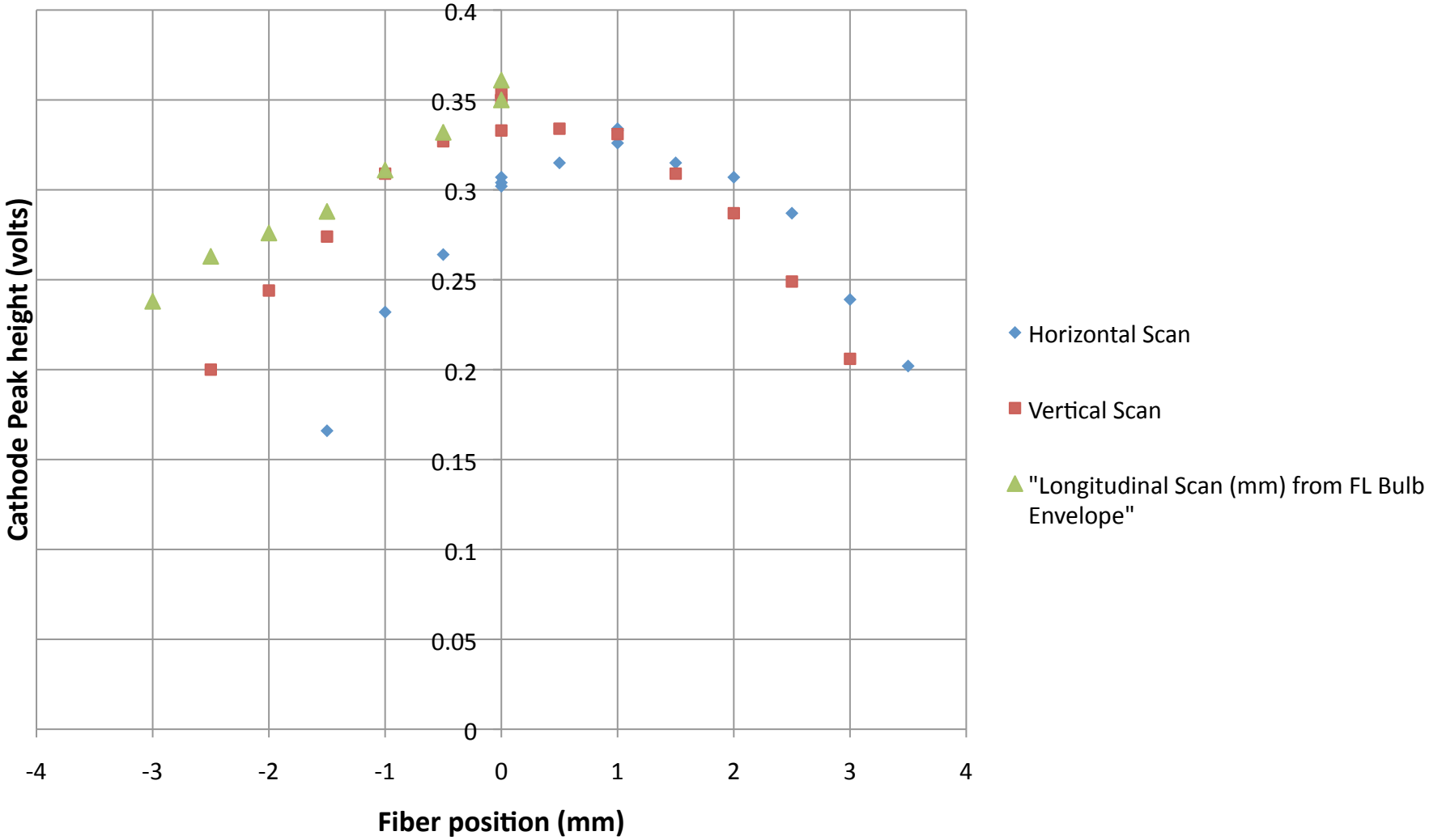


Scanning Procedure

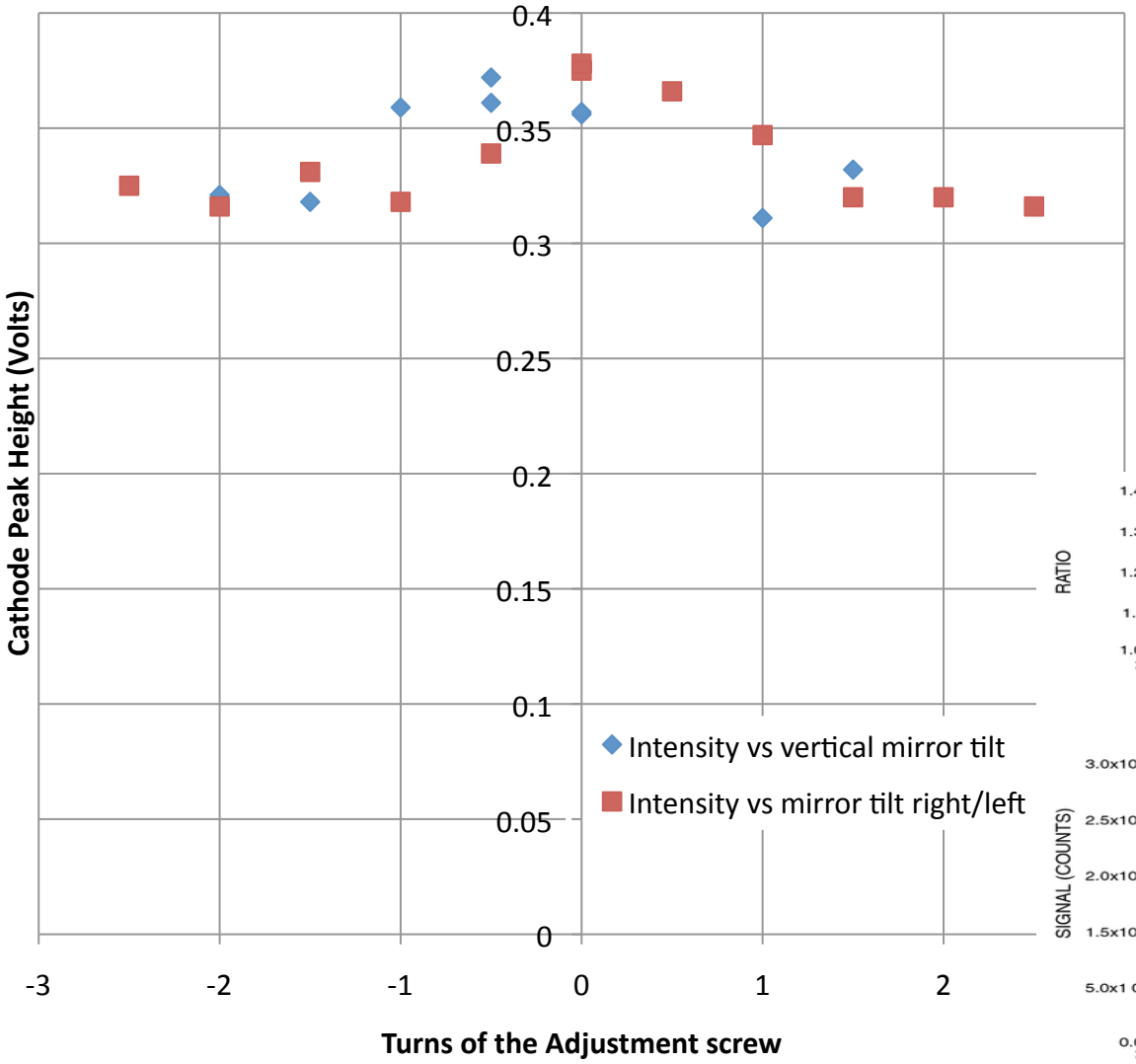
- Intensity curve vs fiber end position.
  - Only the longitudinal position was an absolute location-”0” was where the fiber was ~flush against the bulb envelope.
  - The other vertical/horizontal “0” was setup to be in the middle of the flashlamp arc and centered on the arc axis.
    - A rough scan was done to locate a horizontal-vertical-longitudinal position giving a peak cathode response. This longitudinal position was when the fiber was touching the bulb envelope.
  - Horizontal position scanned first, in 0.5mm steps on both sides of origin.
    - Final horizontal position set to be at nominal peak of curve.
  - Vertical then scanned in 0.5mm steps.
    - Final vertical position was at the nominal peak of vertical scan.
  - With H&V positions at highest peak output, the fiber was backed off the bulb position in -0.5mm steps.

PrM0 Cathode Peak Height vs Fiber position (Inline PrM in 200 micron Vacuum)

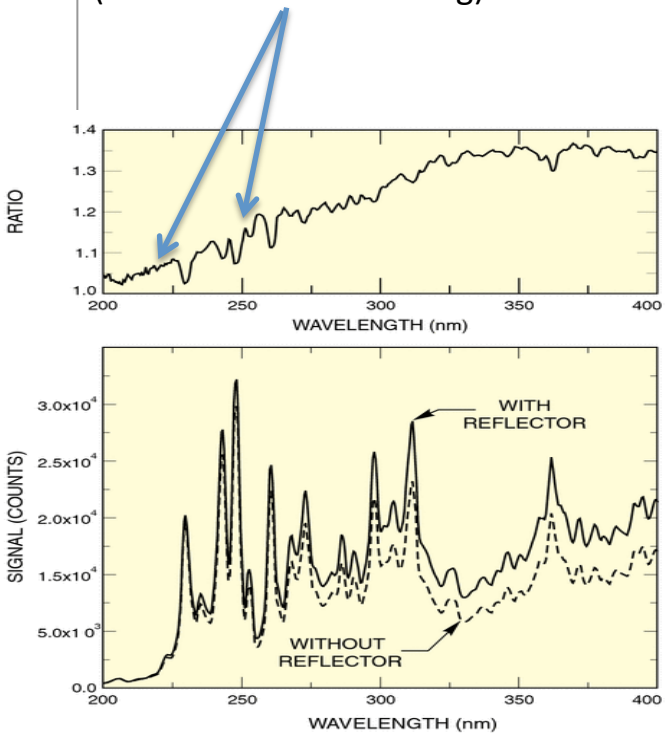
Assuming a gaussian shape, 1 σ ~3 mm on all axes.
Fibers are 0.6mm diameter



Inline PrM Cathode Peak Height vs Reflecting mirror tilt (in turns of the adjustment screw)



Mirror adjustment brings 10-15% to overall intensity for a fiber located at the max signal position.
Consistent with Ratio (with/without reflector) shown below for a reflector (taken from Oriel Catalog)



Other measurements

- With the setup giving the maximum cathode peak signal from the inline PrM, the other two fibers were individually inserted in the holder.
  - The numbering was just the order that the fibers were tested. No other significance.

Fiber	Cathode Signal Peak (volts)
#1	0.375 V
#2	0.254 V
#3	0.114 V
All simultaneously inserted	0.672 V
Sum of 1+2+3 from this table	0.743 V

- Measured values were repeatable over many insertions, so there is something systematic about the individual fibers
  - Checking into this, whether it is the cleaved fiber ends at the bulb, or the ends near the cathode (??)
- The measured Sum of "All simultaneously inserted" is ~ 90% of the simple summation of the three table values. Could be consistent with the pattern shown in plot on page 5

Revisit of Setup 11/24/14

- FL end of FOs were re-cleaved
  - Did quick insertion test with FO position at "optimal" location
    - Setup PrM0, HV, & Flashlamp same as 11/20/14.
  - Shows sensitivity to cleaving.
    - Both on high side and low side
    - Peak values are reproducible over insertions into fiber holder
  - Ordering especially on low side persists over cleaving
    - Suggests problem with low level of #3 may be at cathode side of fiber end.

Fiber	Cathode Signal Peak (volts) (11/20/14)	Cathode Signal after re-cleaving #1 (11/24/14)	Cathode signal after re-cleaving #2 (11/24/14)	Cathode signal after re-cleaving #3 (11/24/14
#1	0.375 V	0.275 V (-0.100 V)	0.270 V (-0.005 V)	-
#2	0.254 V	0.240 V (-0.014 V)	0.245 V (+0.005 V)	-
#3	0.114 V	0.041 V (-0.073 V	0.114 V (+0.073 V)	0.140 V (+0.026V)
All simultaneously inserted	0.672 V	0.512 V	-	-
Sum of 1+2+3 from this table	0.743 V	0.556 V	0.629 V	-